5

Assessment

$$5x - 2 \leq -3(x + 1) + 2$$

$$\frac{3}{x-2} = \frac{4}{x+5}$$

Inherent in the legislation that established the mathematics content standards is the explicit goal that every student will master or exceed world-class standards. The mathematics content standards set many learning goals that were previously viewed as being for only the most advanced students. Such ambitious goals demand a reexamination of the structures and assumptions that have driven the organization of kindergarten through grade eight mathematics programs and high school courses. To achieve world-class standards, each student must be continually challenged and given the opportunity to master increasingly complex and higher-level mathematical skills.

One problem associated with these goals is how best to detect and intervene with students who are at risk of falling behind or with those who can easily exceed grade-level standards. Optimally, no student should be allowed to slip behind for an entire semester or school year and, conversely, no student should be held back from progressing further just because the next level of learning is targeted for the next grade level.

Regular and accurate assessment of student progress in mastering grade-level standards will be essential to the success of any instructional program based on the mathematics content standards and this framework. Ideally, assessment and instruction are inextricably linked. The purposes of assessment that are the most crucial to achieving the standards are as follows:

Regular and accurate assessment of student progress in mastering grade-level standards will be essential to the success of any instructional program.

- *Entry-level assessment.* Do students possess crucial prerequisite skills and knowledge? Do students already know some of the material that is to be taught?
- *Progress monitoring.* Are students progressing adequately toward achieving the standards?
- *Summative evaluation.* Have students achieved the goals defined by a given standard or a group of standards?

Taken together, these forms of assessment will provide a road map that leads students to mastery of the essential mathematical skills and knowledge described in the *Mathematics Content Standards*.

Entry-level assessment identifies what the student already knows and helps the teacher place the student at the most efficient starting point for his or her learning. A properly placed student will not waste time reviewing material he or she has already mastered. Nor will that student find himself or herself lost in instruction that is far beyond the student's current understanding.

Assessment that monitors student progress helps steer instruction in the right direction. It signals when alternative routes need to be taken or when the student needs to backtrack to gain more forward momentum.

Summative evaluation, which has characteristics similar to those of entry-level assessment, is done to determine whether the student has achieved at an acceptable level the goals defined in a standard or group of standards. Summative evaluation answers questions such as these: Does the student know and understand the material? Can he or she apply it? Has he or she reached a sufficiently high level of mastery to move on?

Similarities in Types of Assessments Across Grade Levels

All three types of assessment can guide instruction, and all three share critical characteristics across grade levels.

The exact purpose of each assessment item should be clear. Each item should be a reliable indicator of whether the student has the necessary prerequisite skills to move forward in mastering the standards. Some entry-level assessment items should measure mastery of the immediately preceding sets of standards. Others should measure the degree to which the student already has mastered some portion, if any, of what is to be learned next.

Entry-Level Assessment

Entry-level assessment needs to have a range and balance of items, some of which reach back to measure where students are, while others reach forward to identify those students who may already know the new material.

If entry-level assessments are used to compare the performance of students in the class or are used to establish a baseline for evaluating later growth, they must adhere to basic psychometric principles. That is, they must be:

1. Administered in the same conditions
2. Administered with the same directions
3. Scaled in increments small enough to detect growth

Progress Monitoring

In standards-based classrooms, progress monitoring becomes a crucial component of instruction for every student. It is only through such monitoring that teachers can continually adjust instruction so that all students are constantly progressing. No student should languish and be left behind because of a failure to recognize the need to provide him or her with extra help or a different approach. Similarly, students should not spend time practicing standards already mastered because of a failure to recognize that they need to move on.

Everything students do during instruction is an opportunity for progress monitoring.

In a sense everything students do during instruction is an opportunity for progress monitoring. Teachers should continually look for indicators among student responses and in student work. Monitoring can be as simple as checking for understanding or checking homework, or it may be a more formal type of assessment. Whatever form monitoring takes, it should occur regularly. In addition to regular monitoring to determine students' achievement of particular standards, more general monitoring should be done at least every six weeks.

Another form of monitoring is to make short, objective assessments to ensure that assessment of student learning is consistent for the entire class. Such measures must:

1. Use standardized administration procedures and tasks.
2. Document performance.

3. Be linked to items currently being taught.
4. Help teachers make instructional decisions and adjustments based on documented performance.
5. Indicate when direct interventions are needed for students who are struggling to master the standards.

The importance of using performance data as the basis for making well-informed adjustments to instruction cannot be overstated. Teachers need a solid basis for answering such questions as these:

- Should I move ahead or spend more time on the current phase of instruction?
- Are students able to practice what they have learned through independent activities, or do I need to provide additional instruction?
- Can I accelerate the planned instruction for some or all students and, if so, what is the best way to do that?

Summative Evaluation

Summative evaluation measures on a more formal basis the progress students have made toward meeting the standards. Typically, it comes at the end of a chapter or unit or school year. The most critical aspect of summative evaluation is that it measures the ability of students to transfer what they have learned to related applications. If one summative evaluation in the early grades is a test of computation, some or all of the problems should be new to the students; that is, problems that have not been used extensively during previous instruction.

This characteristic of summative evaluations addresses the concern many teachers have about "teaching to the test." Summative evaluations did not guide the development of the mathematics content standards; the standards provide the basis for developing summative evaluations. Further, summative evaluations are not mere reflections of retained knowledge but are the most valid and reliable indicator of depth of understanding.

Each of the three distinct types of assessment described in this chapter—entry-level assessment, progress monitoring, and summative evaluation—can help to guide effective instruction. Progress monitoring, in particular, can play a key role in developing and delivering curricula and instruction that lead to student achievement of the mathematics standards. Because this framework places substantial emphasis on integrating an assessment system with curricula and instruction, it is critically important for assessment and instruction to be closely interrelated in ways that minimize any loss of instructional time while maximizing the potential of assessment to advance meaningful learning.

Special Considerations in Mathematics Assessment

A feature unique to mathematics instruction is that new skills are built almost entirely on previously learned skills. If students' understanding of the emphasis

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topics from previous years or courses is faulty, then it will generally be impossible for students to understand adequately any new topic that depends on those skills. For example, problems with the concept of large numbers as introduced in kindergarten and the first grade may well go unnoticed until the fifth grade, when they could cause students severe difficulty in understanding fractions. The biggest problem facing mathematics assessment is, therefore, how to devise comprehensive methods to detect the mastery of these basic learned skills.

The biggest problem facing mathematics assessment is, therefore, how to devise comprehensive methods to detect the mastery of basic learned skills.

There are many methods for assessment in mathematics, some of which will be mentioned in the next section. But certain methods, like timed tests, play a more basic role in mathematics assessment than they do in other areas of the curriculum in measuring understanding and skills and in checking whether students have an adequate knowledge base—whether they understand the material with the ease required for future success.

One of the key requirements for instructional materials discussed in Chapter 10 is that the materials provide teachers with resources and suggestions for identifying the basic prerequisite skills needed for the current courses and assessment material and suggestions that will help the teachers measure those skills. It is also recommended that this material include suggestions on how best to handle the most common types of difficulties that students will have.

Methods of Assessment in the Mathematics Curriculum

Many methods of assessment are available for testing knowledge in mathematics. Recently, one of the most commonly used methods, timed tests, has been the subject of intense scrutiny. A timed test requires that a certain number of items be completed within a fixed time limit. The following statement from the 1989 National Council of Teachers of Mathematics (NCTM) standards illustrates some of the issues:

> Students differ in their perceptions and thinking styles. An assessment method that stresses only one kind of task or mode of response does not give an accurate indication of performance, nor does it allow students to show their individual capabilities. For example, a timed multiple-choice test that rewards the speedy recognition of a correct option can hamper the more thoughtful, reflective student, whereas unstructured problems can be difficult for students who have had little experience in exploring or generating ideas. An exclusive reliance on a single type of assessment can frustrate students, diminish their self-confidence, and make them feel anxious about, or antagonistic toward, mathematics (NCTM 1989, 202).

There is certainly an element of truth in this statement and, as is also advocated in the same document, other methods of assessment besides timed tests are appropriate in mathematics instruction.

> Many assessment techniques are available, including multiple-choice, short-answer, discussion, or open-ended questions; structured or open-ended interviews; homework; projects; journals; essays; dramatizations; and class presentations. Among these techniques are those appropriate for students working in whole-class settings, in small

groups, or individually. The mode of assessment can be written, oral, or computer-oriented (NCTM 1989, 192).

All of these techniques can provide the teacher and the student with valuable information about their knowledge of the subject. However, they also represent a serious misunderstanding of what mathematics is and what it means to *understand mathematical concepts. Assessment methods such as timed tests play an essential role in measuring understanding—especially for the basic topics, the ones that must be emphasized.* If students are not able to answer questions in these areas relatively quickly, then their understanding of these topics is too superficial, has not been adequately internalized, *and will not suffice as a basis for further development.* The conduct of ordinary life and success in algebra and higher mathematics presuppose that students can perform basic calculations to the point of automaticity.

Again, the unique aspect of mathematics that was discussed previously must be emphasized. Mastery of *almost all the material* at each level depends on mastery of *all* the basic material at all previous levels. This requirement does not allow for superficial understanding, and the most efficient and reliable method for distinguishing between these levels of understanding remains the timed test.

The level of knowledge of basic topics needed for students to advance further requires that the topics be mastered to the level of automaticity. Consequently, the best method for assessing the basic topics is timed tests.

Students who do not have extensive experience during the school year with standardized, timed tests will be at a marked disadvantage in taking these types of tests; for example, those from the Standardized Testing and Reporting (STAR) Program, *SAT,* and *ACT.*

Readiness for Algebra

The step from grade seven mathematics to the discipline of algebra, which is one of the largest in the curriculum, can be more difficult to bridge than the previous steps from one grade level to the next. Moreover, the current recommendation that algebra be taught at the eighth grade, whereas it was previously taught at the ninth or even the tenth grade, makes this step even greater.

Algebra I is a gateway course.

Algebra I is a gateway course. Without a strong background in the fundamentals of algebra, students will not succeed in more advanced mathematics courses such as calculus. Nor will they be able to enter many high-technology and high-paying fields after graduation from high school (Paglin and Rufolo 1990). *It is therefore essential that the readiness of all students to take eighth-grade algebra be assessed at the end of the seventh grade, using reliable and valid assessment measures.*

One purpose of a seventh-grade assessment, as described previously, is to determine the extent to which students are mastering prealgebraic concepts and procedures. Another is to identify those students who lack the foundational skills needed to succeed in eighth-grade algebra and who need further instruction and time to master those skills. This additional instruction may be provided through tutoring, summer school, or an eighth-grade prealgebra course leading to algebra

in the ninth grade. The needs for such additional instruction will vary among the students, and it follows that *proper assessment at this level is crucial*.

Those students who have mastered foundational skills, as indicated by successful performance on the algebra readiness test, would take algebra in the eighth grade.

The algebra readiness test should assess students' understanding of numbers and arithmetic, including knowledge of prime numbers and factoring, the rules for operating on integers (e.g., order of operations and associative and commutative properties), exponents, and roots. A thorough grounding in fractions, decimals, and percents, and the ability to convert easily from one to the other, is the fundamental algebra readiness skill. Testing students' readiness for algebra implies that options will be required for instructional materials at grade eight to accommodate students who are not ready to take the algebra course.

A thorough grounding in fractions, decimals, and percents, and the ability to convert easily from one to the other, is the fundamental algebra readiness skill.

Students in grade eight or higher who are not prepared to take the algebra course will require instructional materials that give extensive attention to fundamentals in the seventh grade standards and thereby improve the likelihood of students' success in algebra. (See "Algebra Readiness Program (Grade Eight or Above)" in Appendix E.) These instructional materials, by concentrating on a focused subset of the standards, should offer students the opportunity for coverage in depth and for distributed practice on these more challenging areas. Instructional materials should also provide teachers with detailed diagnostic assessments so that students' difficulties with foundational concepts and skills can be readily identified and addressed.

Statewide Pupil Assessment System

A major component of California's statewide testing system is the Standardized Testing and Reporting (STAR) Program. For mathematics STAR is the statewide system for summative assessment. This group of assessments is designed for the evaluation of programs, schools, and districts. Although individual student scores are reported to parents, teachers, and schools, those scores are not normally available until after the end of the school year. Obviously, a clear distinction must be made between the types of formative classroom assessments necessary for teachers to focus their instruction to ensure that all students achieve the standards for their grade level and the summative, large-scale assessments that form the basis of California's accountability system and the accountability requirements of the 2002 federal No Child Left Behind Act.

Standardized Testing and Reporting Program

STAR now consists of four components: (1) the *California Standards Tests (CSTs),* standardized, criterion-referenced tests written specifically for California and aligned with the mathematics content standards; (2) a standardized, norm-referenced test; (3) a standardized, norm-referenced primary language assessment; and (4) an alternate assessment for children with severe cognitive disabilities who

cannot take part in general statewide assessment programs. Characteristics of the STAR Program are that it:

- Requires the assessment of all students in English with a test approved by the State Board of Education
- Assesses achievement in reading, spelling, written expression, and mathematics in grades two through eight; science in grade five; history–social science in grades eight, ten, and eleven; and reading, writing, mathematics, and science in grades nine through eleven
- Requires testing of academic achievement in the primary language for English learners enrolled for fewer than 12 months (optional thereafter)
- Generates the results of testing for individual students and reports to the public the results for schools, school districts, counties, and the state
- Disaggregates the results by grade level, gender, economic disadvantage, major racial and ethnic groups, students with disabilities, and English learners for reports to the public
- Provides both criterion-referenced (standards-based) and norm-referenced results

The State Board of Education has adopted the following performance levels to be used in reporting the results of the *California Standards Tests*: advanced, proficient, basic, below basic, and an additional level designated as far below basic. The first four levels correspond with those used by the National Assessment of Educational Progress; the level far below basic is used to provide additional information. The *California Standards Tests* address all the categories of the mathematics content standards.

Finally, California established the *California High School Exit Examination (CAHSEE)* to ". . . significantly improve pupil achievement in high school and to ensure that pupils who graduate from high school can demonstrate grade-level competency in reading, writing, and mathematics . . ." (Senate Bill 2, Section 1[b][O'Connell, 1999]; codified in *Education Code* Section 60850[a]). Beginning in the 2005–06 school year, in addition to meeting the district's requirements for graduation, high school students must pass the *CAHSEE* to receive a public high school diploma.